Institution: The University of Edinburgh

Unit of Assessment: UoA5: Biological Sciences

Title of case study:

08. Pain research improves welfare of fish

1. Summary of the impact

Impact on society, culture and creativity: Public debate has been stimulated and informed by the UoE research demonstrating that fish feel pain.

Impact on policy, animal welfare, commerce and production: UK, EU and RSPCA Animal Welfare policies and guidelines have been informed by the research. Aquaculture has adopted welfare for fish with the use of humane slaughter methods adopted in many farms.

Beneficiaries: Millions of farmed fish in the EU (including at least 75,000 tonnes of salmon produced annually in Scotland); the aquaculture industry; fish used in research; animal welfare organisations and public awareness.

Significance and Reach: Public interest in the debate has been worldwide; the impact on animal welfare practices is clearly evidenced in the EU.

Attribution: The Principal Investigator was Victoria Braithwaite, Reader at School of Biological Sciences, University of Edinburgh. Mike Gentle, Co-investigator, and Lynne Sneddon, PDRA, were at Roslin Institute, UoE.

2. Underpinning research

Nociception is the detection of a noxious tissue-damaging stimulus and is sometimes accompanied by a reflex response such as withdrawal. Pain perception, as distinct from nociception, has been demonstrated in birds and mammals but had not been systematically studied in lower vertebrates. UoE research led by Victoria Braithwaite and Mike Gentle assessed whether teleost (bony) fish possessed cutaneous nociceptors capable of detecting noxious stimuli and whether their behaviour was sufficiently adversely affected by the administration of a noxious stimulus to suggest discomfort. Electrophysiological recordings from trigeminal nerves identified polymodal nociceptors on the head of the fish with physiological properties similar to those described in higher vertebrates. These receptors responded to mechanical pressure, temperatures greater than 40°C and 1% acetic acid. Administration of noxious substances to the lips of the fish affected both its physiology and behaviour and resulted in a significant increase in opercular beat rate and the time taken to resume feeding, as well as anomalous behaviours. This study [1] provided significant evidence of nociception in teleost fishes and demonstrated that behaviour and physiology are affected over a prolonged period of time, suggesting discomfort.

Further research [2] by Braithwaite, Sneddon and Gentle aimed to assess fear responses to a novel object while experiencing a noxious event to determine whether nociception or fear will dominate attention in rainbow trout. The degree of neophobia to a novel object while experiencing noxious stimulation, or a control treatment treated with a non-noxious stimulus, and the effects of removing the nociceptive response by morphine administration and examining the response to a novel object were studied. Control animals displayed a classic fear response to the novel objects and spent most of their time moving away from this stimulus, as well as showing an increase in respiration rate when the novel object was presented. In contrast, noxiously stimulated animals spent most of their time in close proximity to the novel object and showed no additional increase in respiration rate to novel object presentation. There was evidence of a slight hypoalgesia in noxiously stimulated animals. The responses to familiar objects demonstrated that by familiarizing the animal with the object, fear was removed from the experiment. Both control and noxiously treated animals responded in similar ways to a novel object by spending the majority of their time in close proximity. Treatment with morphine reduced effects of noxious stimulation and appears to be an effective analgesic [2, 3]. After morphine administration, the acid-injected animals showed a neophobic response to a novel object and this was similar to the response of the control fish, with a

similar amount of time spent moving away from the object and an increase in ventilation in response to the novel object. Morphine affected the fear response because both groups approached the novel object more quickly than the non-morphine controls. The results suggested that nociception captures the animal's attention with only a relatively small amount of attention directed at responding to the fear of the novel object, indicating that fish do feel pain. This research provided the first conclusive evidence of pain perception in teleost fish.

Key personnel, all at UoE on dates shown: Victoria Braithwaite, Principal Investigator, School of Biological Sciences (1995-2007). Mike Gentle (UoE Roslin Institute) was co-investigator and Lynne Sneddon was PDRA (UoE 2000-2002; work carried out at UoE in this period was published in 2003 after Sneddon had moved to Liverpool)

3. References to the research

1. Sneddon, L.U., Braithwaite, V.A., Gentle, M.J. (2003). Do fishes have nociceptors? Evidence for the evolution of a vertebrate sensory system. *Proceedings of the Royal Society B: Biological Sciences*, **270,** 1115-1121. doi: 10.1098/rspb.2003.2349.
   143 Scopus citations at 16/10/2013

2. Sneddon, L.U., Braithwaite, V.A., Gentle, M.J. (2003). Novel Object Test: Examining Nociception and Fear in the Rainbow Trout. *Journal of Pain*, **4,** 431-440. doi: 10.1067/S1526-5900(03)00717-X
   81 Scopus citations at 16/10/2013

3. Sneddon, L. U. (2003) The evidence for pain in fish: the use of morphine as an analgesic. *Applied Animal Behavior Science,* 83, Issue 2, pp153-162.
   doi: http://dx.doi.org/10.1016/S0168-1591(03)00113-8
   110 Scopus citations at 16/10/2013

4. Braithwaite, V.A., Boulcott, P. (2007). Pain perception, aversion and fear in fish. *Diseases of Aquatic Organisms*, **75,** 131-138. doi:10.3354/dao075131
   36 Scopus citations at 16/10/2013

4. Details of the impact

The UoE research indicating that fish can feel pain stimulated public debate about sport angling and fishing for food, and contributed to changes in animal welfare policies affecting research animals and farmed fish.

Impact on society, culture and creativity: public debate

The research was widely reported at the time of publication in 2003 (e.g. BBC: http://news.bbc.co.uk/1/hi/sci/tech/2983045.stm. Braithwaite subsequently (2010) published a book based on this research: '**Do Fish Feel Pain?**' [a], to positive reviews by both the scientific and lay press.

> *'An accessible and compelling account...her book will make an important contribution to the debate.'* - Anne Magurran, Times Literary Supplement

It is available in hardback and e-book format. Over 2,500 copies have been sold worldwide during the REF impact census period.

The publication of Braithwaite's book gave rise to press attention and debate world-wide. Peter Singer, Professor of Bioethics at Princeton University, wrote the article 'If fish could scream' which was published by public debate forum Project Syndicate [b]. This was reproduced globally in news media including the Guardian newspaper (http://www.theguardian.com/commentisfree/cif-green/2010/sep/14/fish-forgotten-victims) and translated into at least nine languages including Chinese and Russian. Numerous other articles appeared in local and national press including an

article published on the 'care2make a difference' website in Jan 2013 [c] which had 1,777,951 unique visitors, 1828 of whom shared it on Facebook and it attracted 699 comments. Other media interest included articles in international media and publications such as Daily India (e.g. http://www.dailyindia.com/show/412730.php), the online arm of the Philadelphia Enquirer in the USA (http://articles.philly.com/2011-11-07/news/30369892_1_fish-species-brains), and a feature on Discovery news which was widely reproduced elsewhere [d].

Animal rights and welfare organisations have widely quoted the research to support their campaigns. People for the Ethical Treatment of Animals (PETA) is the largest animal rights organisation in the world, with more than 3 million members and supporters. They quote the UoE research and Braithwaite's book in their campaigns aimed at the general public and to lobby angling communities world-wide on the ethics of fishing [e]. For example they flew an aeroplane banner entitled 'Fish feel pain - hooks hurt' over the Milwaukee Brew City Salmon Tournament in 2010, campaigned in Virginia in 2011, in Seattle (one of the biggest fishing cities in the USA) in 2011 and in Pensacola in 2012. Fishcount is a UK-based website which aims to increase understanding of fish sentience, raise awareness and promote solutions to the suffering of fishes in commercial fishing and also aims to increase awareness of the welfare issues in fish farming. They refer to the UoE research and Braithwaite's book, throughout their website and publications [f].

Impact on public policy debate, changes to guidelines, and animal welfare

(i) Animals used in scientific procedures

A 2006 review by the UK Government Animal Procedures Committee (APC) of Schedule 1 of the UK Animals (Scientific Procedures) Act 1986 noted that there was a need for further consideration of techniques for the humane killing of fish, arising from new understanding on fish pain and welfare [http://www.official-documents.gov.uk/document/hc0708/hc00/0041/0041.pdf]. The Housing and Husbandry subcommittee was tasked by APC to provide a supplementary report on the humane killing of fish. Braithwaite and Sneddon contributed expert advice based on their research papers [1,2,3] that helped inform the **APC Supplementary Review of Schedule 1 of the 'Animals (Scientific Procedures) Act 1986: Appropriate methods of humane killing for fish'** published in June 2009 [g, h]. This report also references paper [4].

Advice from this supplementary Review was submitted to the Home Secretary and contributed to guidance for the revised Schedule 1. It is the understanding of the Review Chair that these recommendations were also submitted onward to the European Commission. The European Directive 2010/63/EU on the protection of animals used for scientific purposes was adopted on 22 September 2010 and was transposed to UK legislation, and included directives for humane killing of fish. The revised Schedule 1 of the Animals (Scientific Procedures) Act 1986 came into effect on 1st January 2013.

(ii) Farmed fish

In 2008 the EU commissioned the European Food Safety Authority (EFSA) to deliver a Scientific Opinion on welfare aspects of farmed fish [i]. This Scientific Opinion was developed by EFSA's Animal Health and Welfare (AHAW) panel and was adopted by EFSA on 29 January 2009. The report extensively referenced the two 2003 papers [1, 2] in the discussion of fish pain (Section 5) and concluded that 'the balance of the evidence indicates that some fish species have the capacity to experience pain' and that 'responses of fish, of some species and under certain situations, suggest that they are able to experience fear'.

Aquaculture is the fastest growing form of farming with large facilities producing an estimated 6,400-110,000 million fish per year globally. Atlantic salmon is the most commonly farmed species in the UK, with approximately 70 companies producing over 140,000 tonnes of farmed salmon each year (RSPCA figures). 90% of this occurs in Scotland and it is Scotland's largest export. The UK RSPCA published Welfare Standards for farmed Atlantic salmon in October 2012 (http://www.rspca.org.uk/ImageLocator/LocateAsset?asset=document&assetId=1232731074670&mode=prd). These state that 'scientific evidence from behavioural, physiological and anatomical studies shows that it is highly likely that fish feel pain. It is essential that staff managing farmed fish are aware of the importance of welfare as an integral part of production'. Over 60% of Scottish farmed salmon producers have 'Freedom Food' (the RSPCA's farm assurance and food labelling

scheme) accreditation and this is increasing. One Scottish salmon farm manager quoted by the Freedom Food documentation confirms the importance of the understanding that fish feel pain to this approach to farming:

> *"Some people don't associate fish with pain and stress. But they feel both, just like other sentient beings and it's really important to me and all who work for me, that we rear them to high welfare standards." [j]*

In December 2012, over 100 million salmon were farmed in accordance with the RSPCA's Freedom Food welfare guidelines. This improvement in fish welfare originated in the 2003 UoE publication which contained the first widely-reported demonstration that fish feel pain.

5. Sources to corroborate the impact

The Tiny URLs provide a link to archived web content, which should be accessed if the original website content is no longer available.

a. Do Fish Feel Pain? by Victoria Braithwaite (978-0-19-955120-0), published 25th March 2010 (available on request).

b. If fish could scream (Project Syndicate) http://www.project-syndicate.org/commentary/if-fish-could-scream or http://tinyurl.com/pu9o75x

c. Care2makeadifference http://www.care2.com/causes/fish-feel-fear-and-pain-and-stress.html or http://tinyurl.com/pmjopvz

d. Website that references Discovery news feature (Discovery page itself is no longer available): http://psychologyofpain.blogspot.co.uk/2010/12/fish-feel-pain-too-discovery-news.html or http://tinyurl.com/ozf3jlx

e. PETA website sections on fishing for food (http://www.peta.org/issues/animals-used-for-food/fish-feel-pain.aspx) or http://tinyurl.com/nquq7aa and for sport (http://www.peta.org/issues/animals-in-entertainment/Fishing.aspx) or http://tinyurl.com/pejr3cx both reference the UoE research.

f. Fishcount website: http://fishcount.org.uk/ or http://tinyurl.com/pyqpwrs ; http://www.fishcount.org.uk/published/standard/fishcountfullrptSR.pdf (copy also available on request)

g. Contribution of Braithwaite and Sneddon's research can be corroborated by the Chair of the committee which produced the APC supplementary review: Deputy Scientific Director at Universities Federation of Animal Welfare (UFAW), the independent international animal welfare scientific society.

h. Animal Procedures Committee Supplementary Review of Schedule 1 of the Animals (Scientific Procedures) Act 1986: Appropriate methods of humane killing for fish. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/119018/humane-killing-fish.pdf (copy of pdf also available on request).

i. EFSA scientific opinion on fish welfare: http://www.efsa.europa.eu/en/efsajournal/pub/954.htm (copy of report also available on request)

j. Quoted in Freedom Food leaflet: http://www.freedomfoodpublications.co.uk/impact_report/ImpactReport_Optmised.pdf (copy of pdf also available on request).